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Applicant: Volkswagen AG, 38440 Wolfsburg, DE

Inventor: Schaaf, Klaus, Dr., 38116 Braunschweig, DE

Publications taken into consideration when judging patentability:

DE	40 29 697 C2
DE	693 14 514 T2
EP	07 95 851 A2
EP	07 73 531 A2
EP	07 21 178 A2

The following specifications are taken from the documents submitted by the applicant

Process and device for operating a microphone configuration, in particular in a motor vehicle

The invention relates to a process as well as a device for operating a microphone configuration, in particular in a motor vehicle, according to the preamble of patent claims 1 and 6.

In order to improve fundamentally in a process as well as a device of this type the recording quality of the speech signal input into the system, the invention proposes that for tracking a virtual microphone location optimized with respect to the position of a movable speech source, the speech sound is acquired at several spatially distributed locations and from the evaluation of variables, such as delay time and/or phase and/or amplitude, the discrete microphone locations are weighted virtually and the audio signals of the microphones are correspondingly added or combined otherwise.

Specification

The invention relates to a process as well as a device for operating a microphone configuration, in particular in a motor vehicle, according to the preamble of patent claims 1 and 6.

Microphones or microphone configurations are required in motor vehicles in particular for operating the so-called hand set-free speaking system, in addition, however, also in speech amplification and transmission systems and in systems for active noise suppression.

It is herein important that the sound is picked up or can be picked up in the immediate proximity of the head of the motor vehicle passenger or the vehicle driver. For this purpose microphones are disposed most frequently in the area of the instrument panel or in roof fittings or on the interior mirror. In otherwise simple hand set-free speaking devices in car telephone systems or also in speech-controlled input interfaces on electronic apparatus, simple microphones or microphone configurations often present problems. The voice messages are therein overlayed with driving noises, which becomes problematic not only in hand set-free speaking telephone systems but also in voice-controlled input units.

DE 196 08 869 A1 discloses a voice operating device for components in motor vehicles, in which the actuation of the operating device has not been correctly accepted by the operating device. A voice operating device of this type with respect to its microphone implementation concentrates only on a conventional microphone development or microphone configuration.

From DE 195 33 541 C1 is known a voice-controlled operating process of similar type. However, herein the voice control is dealt with as such. In order to attain herein reliable operation, a highly expensive voice recognition process is used, in which the aspects of noise reduction, echo compensation, characteristic extraction, syntax and semantic checking are dealt with separately. The issue here is only one of postprocessing the available voice signals in the best feasible way. An improvement

of the voice quality as such, or an improvement of the voice signal pick-up is herein not included in the consideration.

From EP 0721178 A2 a multi-channel communication system with several microphones and several loudspeakers is known. The entire system is therein layed out for at least two speaking persons, who are connected in transmission/reception operation. The transmission means select the voice message from a total noise background. In an application for motor vehicles a so-called error or comparison microphone is brought above the safety belt very close to the speaking person. The microphone location is herein also not fixed. For the remainder, the implementation according to this document is layed out for transmitting/receiving operation of two or more persons.

Moreover, from EP 0773531 A2 a frequency-selective control system for acoustic systems is known. Herein the prevention of overdriving is the main focus. An improvement of the receiving quality of the voice message is herein not included in the consideration. A system of similar type is also known from EP 0721179 A2. The adaptive tonal control system disclosed here for eliminating stability problems superficially also relates to the prevention of the already described overdrive.

This cross section of prior art shows basically that the interest lies largely with improving the already received voice signals. An improvement of the pick-up quality at the location of voice generation is however often, if not fundamentally always, neglected.

The invention is thus based on the task of developing further a process as well as a device according to the type to the extent that the pick-up quality of the voice signal input into the system is in principle improved.

The posed task is solved in a process of the type according to the species according to the invention through the characterizing characteristics of patent claim 1.

With respect to a device of the type according to the species, the task posed is solved according to the invention through the characterizing characteristics of patent claim 6.

Further advantageous implementations of the process according to the

invention are specified in claims 2 to 5, and further going developments with respect to the device according to the invention are specified in the remaining patent claims 7 to 10.

Central point of the invention in terms of process as well as also in terms of device is the fixing of a virtual optimized microphone location. Based on the determinations it is virtually fixed, where the source of the voice is, i.e. at the location of the head of the speaking person. This so-called spatial noise or voice source recognition can be carried out, for example, by means of delay time measurements. In a configuration with multiple microphones this leads to the fact that during the speaking process the voice source can be detected in its spatial position by means of a delay time measurement. The microphones are added in terms of amount and phase such that the useful signals are added and amplified, but the background noise signals, not correlated with the useful signal, are optimally excluded. Consequently, all microphones have a supporting function and are included in the evaluation. This is not a posttreatment of the microphone signals but rather an improvement of the voice signal supplied into the transmission chain.

The fundamental concept of the invention in terms of process as well as also device is especially advantageous thereby that a microphone selected in this manner or the delay time measurement forming the basis here can be combined with a position determination of the head of the speaking person.

While from US 5366241 means are known for determining the head position which serve for the airbag control, the head position is determined with generated sound waves. A combination with a voice-operated microphone is therein not described.

In further advantageous development, the head position data, which in this case are generated via the voice source recognition or the so-called virtual microphone location determined, via which the safety systems can be addressed specifically. In other words, parallel to the conventional speaking operation in car telephones or voice input units, additionally the head position is determined without having to make available further means. If the head is in an unfavorable position

with respect to the airbag system, the safety system, if needed, can be driven such that triggering the air bag is omitted.

Consequently, the system is overall multifunctional, wherein, however, the increase of the voice quality at the pick-up location is substantially given. This leads to a more understandable transmission during the speaking operation in the case of a car telephone system. Moreover, in voice input controlled units in the motor vehicle the voice commands are more reliably recognized and converted.

The invention is depicted in the drawing and, in the following, will be described in further detail. Therein show:

Fig. 1 fundamental structure in system overview,

Fig. 2 embodiment example of an electronic structure according to the invention.

In Figure 1 the structure of the basic elements as well as the functional connection of the same is shown. Detailed representations are omitted and only a system overview is shown.

A multiplicity of microphones 1, 2, 3, is disposed spatially distributed within the motor vehicle. With a correspondingly favorably selected positioning also a configuration comprising two microphones may be sufficient. Moreover, it can be entirely advantageous to dispose even more than three microphones. The selection of the microphone locations is therein as desired and consequently can be either fixedly installed in fittings or by means of further fastening elements can be spatially distributed in the motor vehicle.

The basic fact remains, however, that per seat several microphones are required. But for an exact 3-D localization, 3 microphones are required. The microphone locations must define a three-dimensional space and must not lie in one plane. If, however, the microphones are too far removed from one another, the delay time or correlation measurement is not sufficiently precise.

All of the microphones supply a corresponding signal which is combined in a

signal evaluation 10. If in the motor vehicle a voice message is output, it is received by all microphones. However, since these are spatially distributed, for one, the quality of the received signal differs and, for another, delay time differences are generated with highly precise evaluation, which are generated by the limited speed of sound. Within the signal evaluation 10 subsequently a delay time determination is carried out, and from the correlation of all microphone signals, the location of the noise or voice generation is determined. The thus determined spatial coordinates for the voice source subsequently permit the electronic determination of the so-called virtual microphone location. This means, in other words, that the multiplicity of the microphone signals from the distributively disposed microphones through the correlation of all signals yield said virtual microphone location, which reproduces the most favorable position with respect to the head of the speaking person. If the position of the head is not changed, this is again registered accordingly by the multiple configuration of the microphones and by means of said delay time measurement, the virtual microphone location is quasi tracking through a shift of the weighting of the microphone signals. Since the weighting takes place electronically, the entire process runs nearly without delay, i.e. without significant noticeable time delay.

A further method can, however, also comprise that fundamentally always all microphone signal are weighted, and by means of a plausibility check, by comparing the discrete microphone signals, the voice message can be continuously verified.

Independently of the actually present method, the signal evaluation 10 in one implementation of the invention is connected bidirectionally in terms of signal technology with a succeeding microphone location determination unit 20. Within this microphone location determination unit either a receiving lobe determination and a corresponding calculation can be carried out or the selection of the instantaneous main microphone can be fixed.

The microphone determination unit 20 is, in turn, in terms of signal technology connected with an arithmetic unit 30, with the aid of which from the determined data or signals a position determination of the head is carried out. The further going

calculation, for example, can lie in a comparison with patterns. The comparison with patterns can therein considerably shorten the computing time because in this case it is not necessary to calculate each time *ab initio*. The so-called "out of position" position of the head of the speaking person, in view of an airbag triggering can be recognized immediately. Therewith the calculation unit 30 is subsequently connected with the signal generation for the safety systems 40, such as airbag, belt tightener and the like.

The bidirectional connection SB between the signal evaluation 10 and the microphone location determination unit 20 makes possible the driving of the microphones which form herein the center, as a function of the position of the head of the speaking person.

If the head of the corresponding person is moved during speaking operation, through the invention, a so-to-speak tracking of a virtual microphone takes place, i.e. if the speaking operation starts at a position-optimized microphone X 1 and if the position changes during the speaking operation, a tracking of the optimum microphone location task place during the speaking operation, for example, by a shift onto microphone X 2 as quasi dominant microphone. In other words, the virtual microphone location, once determined as being optimal, naturally changes if the position of the head of the speaking person changes. This is included in the essence of the invention and solved here in advantageously simple manner. It is a special case if the virtual microphone location coincides with one of the actual microphones. However, mainly a collective microphone signal weighting takes place, in which the directional characteristic is adapted to the changed position of the head through appropriate shifting of the quasi order of rank in the weighting of the individual microphone signals.

The microphone locations of the distributively disposed microphones depend on the motor vehicle configuration. In principle advantageous is thus the disposition of at least 2 microphones per person. It is also possible that an uneven number of microphones is used, wherein in this case one or several microphones are assigned to several persons.

Figure 2 shows a simple basic circuit configuration for realizing the function

only depicted systematically in Figure 1.

The microphones 1, 2, 3 are each connected with a variable amplifier. These variable amplifiers are controlled via the weighting device 7. Two of the variable amplifiers can at the control side also be coupled or coupled in correlation. Furthermore, the individual amplifier output signals can also be impressed on said weighting device 7. In parallel. the amplified microphone signals are switched to an adder 8, which, at the output side, is connected to the device 9 for the transmission of the audio signals.

Patent Claims

1. Process for operating a microphone configuration, in particular in a motor vehicle, **characterized in that** for tracking a virtual microphone location, optimized with respect to the position of a movable voice source, the voice sound is picked up at several spatially distributed locations and, from the evaluation of variables, such as delay time and/or phase and/or amplitude, the discrete microphone locations are weighted and the audio signals of the microphones are correspondingly added or otherwise combined.

2. Process for operating a microphone configuration as claimed in claim 1, characterized in that the evaluation of the microphone signals or the virtual microphone location determination takes place through a sound delay time evaluation to or between the discrete microphones.

3. Process for operating a microphone configuration as claimed in one or several of the preceding claims, characterized in that through simultaneous evaluation of all microphone signals the directional characteristic of the entire microphone configuration tracks the changed position of the voice source through shifting of the amplification or the phase or the delay time of the discrete microphone signals.

4. Process for operating a microphone configuration as claimed in one or several of the preceding claims, characterized in that from the determined variables or parameters the position of the head/voice source is determined and this is drawn on as a decision criterion for triggering safety systems, such as an air bag.

5. Device for operating a microphone configuration, in particular in a motor vehicle, in which via the microphone configuration voice signals can be input into an audio or telephone system or into voice-controlled input units of apparatus, or within the framework of an active noise compensation, characterized in that the microphone configuration comprises at least two spatially distributively disposed microphones (1, 2, ...), that the signals of all microphones (1, 2, ...) can be joined for a signal evaluation (10), and that this signal evaluation (10) is subsequently logically linked with means (20, 30) such that from the totality of the microphone signals a microphone optimal with respect to the sound or voice source or a collectively determinable directional characteristic can be temporarily selected or driven.

6. Device for operating a microphone configuration as claimed in claim 5, characterized in that said means comprise a microphone location determination unit (20) and a succeeding further calculation unit (30).

7. Device for operating a microphone configuration as claimed in claim 6, characterized in that within the microphone location determination unit (20) from the simultaneous weighting of all microphone signals a virtual microphone location determination can be carried out, which can track the movable position of the voice source.

8. Device for operating a microphone configuration as claimed in one or several of claims 5 to 7, characterized in that the technical signal connection between signal evaluation (10) and the microphone location determination unit (20) is layed out bidirectionally such that via the result determinable in the microphone location determination unit (20) of the virtual microphone location, a return signal can be transmitted to the signal evaluation (10), in order to drive specifically or call up the microphones (1, 2, 3).

9. Device for operating a microphone configuration as claimed in one or several of claims 5 to 8, characterized in that the arithmetic unit (30) in which from the determined data the particular current position of the sound source is determinable, a weighting takes place such that in correspondingly unfavorable position a blocking signal is output to the safety systems (40), such as air bag, belt tightener and the like.

10. Device for operating a microphone configuration as claimed in one or several of claims 5 to 8, characterized in for the weighting in terms of determination of the microphone signals the microphones (1, 2, 3) are at the output side connected with a variable amplifier (4, 5, 6) each of which is variable individually or coupled via a weighting device (7), that the outputs of the amplifiers (4, 5, 6) are connected with an adder (8) connected with a device (9) for transmitting the audio signals, and the particular outputs of the amplifiers (4, 5, 6) are connected in parallel also with the weighting unit (7) so as to feed back data.

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2 sheets of drawings enclosed

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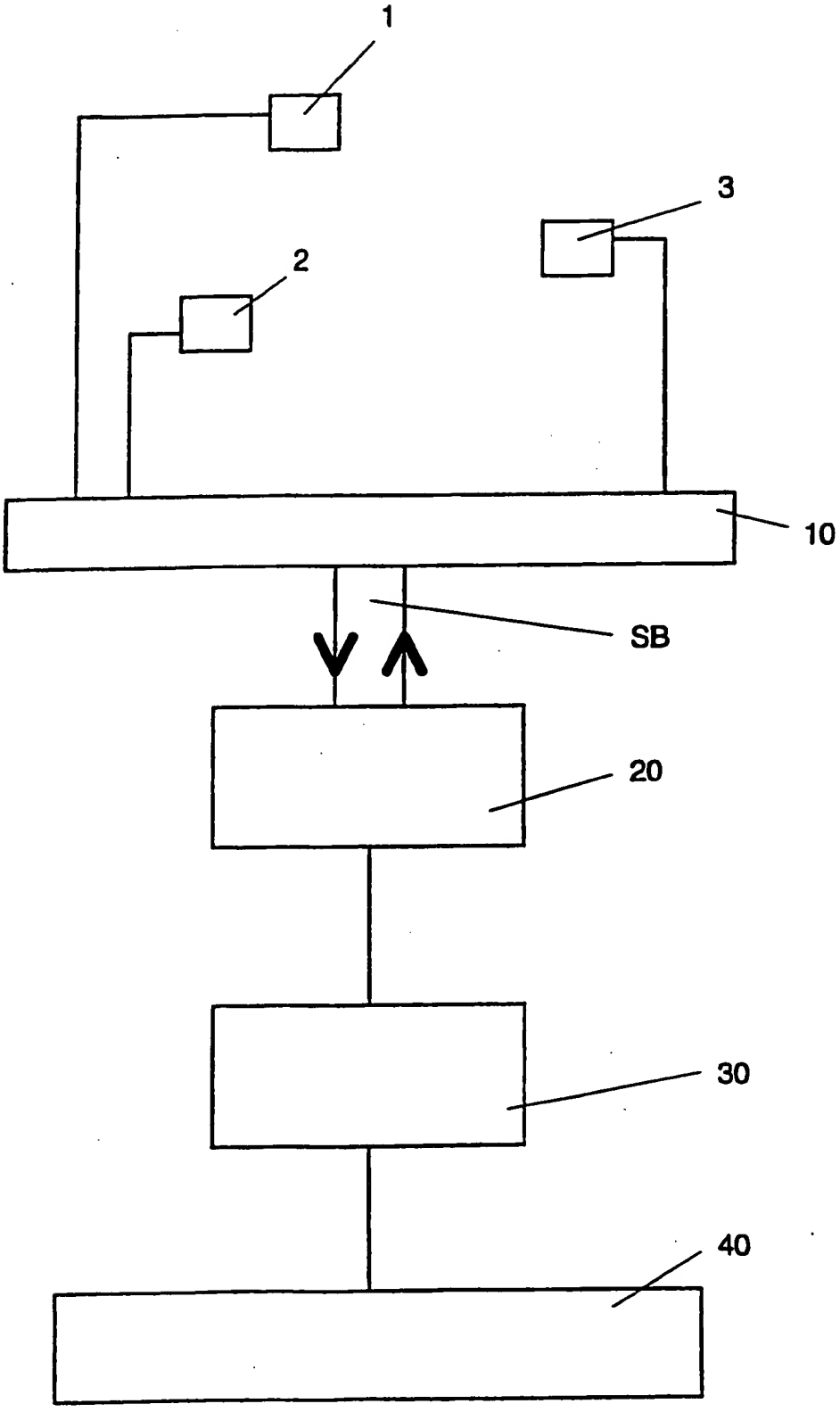

Fig 1

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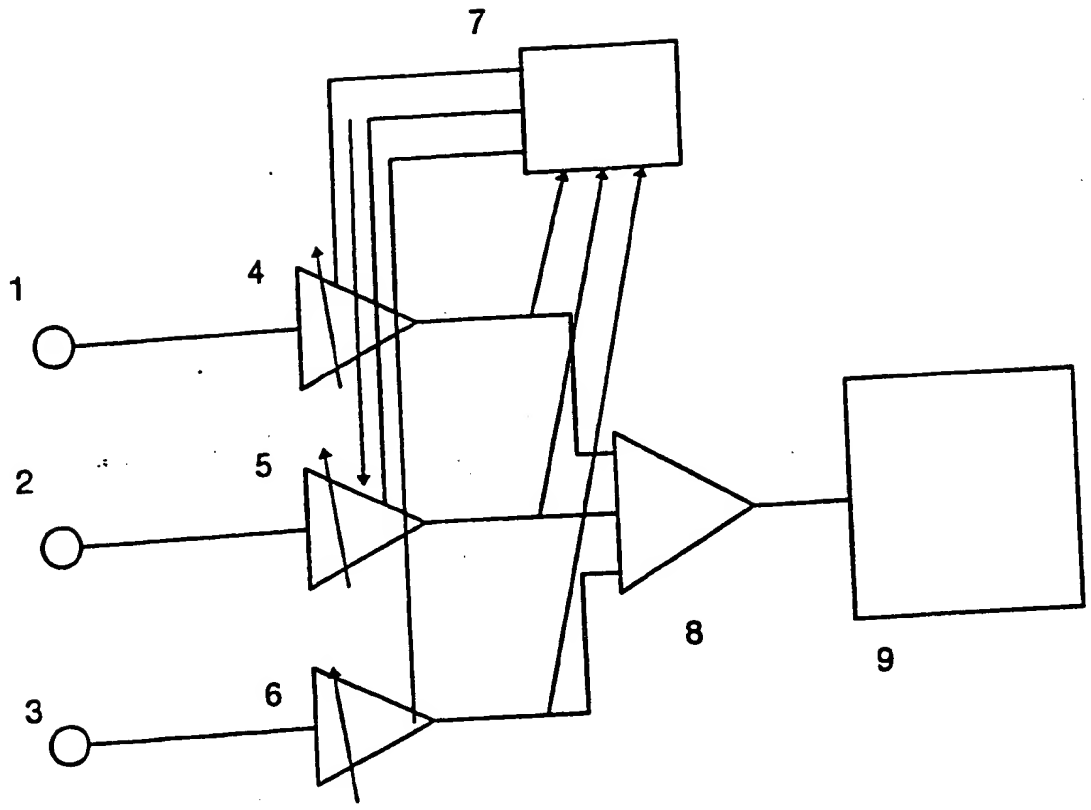

Fig 2